edition, subject geology, part 5), gives exactly that view of the matter which I consider the logical basis on which Professor Huxley rested his argument, and which recent researches have in no way tended to upset. E. NUGENT.

Pottstown, Dec. 27, 1883.

SIR CHARLES WILLIAM SIEMENS.

CARL WILHELM SIEMENS died in London on the 20th of November last, at the age of sixty. This distinguished man, better known to the people of Great Britain and the United States as Charles William Siemens, one of eight sons of Ferdinand Siemens, was born at Lenthe, near Hannover, April 4, 1823. He was one of a family of men of science several of whom have become well known by their success in the invention and introduction of improvements and modification of standard methods of engineering and metallurgical work. Among these, his brother, Ernst Werner Siemens, is the most famous. The two brothers have worked together, with frequent assistance from a younger brother, Friedrich, in nearly every field of applied science. They have been most successful in the departments of metallurgy and electricity.

The elder brother, Ernst, entered the army of Prussia, joining the artillery; and Carl was sent to the University of Göttingen. Carl received his preparatory education at the Gymnasium of Lübeck and in the Art school of Magdeburg, near what was formerly the home of Otto von Guericke. After graduation from the university, he entered the Stolberg engineering-works, in 1842, as an apprentice, but remained only a year, leaving for the purpose of going to London to patent and introduce his first invention, the 'differential governor' for steam-engines, and a method of silvering devised by his brother Ernst. He settled in London, opening an office as civil engineer, and making that city his home, becoming 'naturalized' in 1849, but frequently visiting Germany to meet his brothers, who finally joined him in business.

In 1846 the brothers began the study of methods of economizing in the use of fuel in metallurgical operations demanding high temperatures; and the result of their labors, in course of time, was seen in the invention of the Siemens regenerative furnace, — an invention which has since revolutionized the methods of production of steel and of heating iron, and which is still modifying all the industrial operations dependent upon the attainment of maximum heat in furnaces; such as the manufacture of glass, and the reduction of ores of zinc and other 'useful' metals. In 1849 the brothers William and Werner, as they came to be called, attracted the attention of all who were interested in the applications of science by the announcement of their invention of a method of 'anastatic printing,' modifications of which have now become generally introduced for the production of the simpler kinds of line-engravings. This invention greatly interested Professor Faraday, and he was very soon sufficiently well convinced of its value to volunteer to describe it in a lecture before the Royal institution. His helpful aid was one of the most effective means of making the talented young inventors known and of giving them a start in a career bringing them continually increasing fame.

Siemens next turned his attention to the newly announced dynamical theory of heat, and in 1847 adapted a 'regenerator' to a superheated steam-engine. Modifications of the governor for controlling the motion of clock-work were proposed by him at nearly the same time, and his 'chronometric governor' has been long in use on the instruments of the Greenwich observatory. In 1851 he brought out his water-meter, — an instrument in which was a screw with its recording or indicating mechanism sealed in a chamber having a glass window, through which the readings could be made, and so free from friction that it gave most accurate measures of the flow. The regenerative furnace now began to take such shape that the brothers found it to their interest to devote their attention to that; and in 1856 they worked the invention into such form that they could see in it the promise of complete success. By the year 1861 they had patented some of its most essential features. The inventors succeeded in raising the necessary capital, and erected their furnace in works at Birmingham in 1866, and made steel by their process, which was exhibited at Paris at the international exhibition of the following year. The primary object held in view by the inventors was the manufacture of steel directly from the ore. In this they were less successful than in the making of the steel by mixture of wrought-iron scrap with cast iron on the hearth of their reverberatory furnace. This last-named process has become a well-known method of producing the soft ingot-irons misnamed steels, 'mild' or 'low' steels, which materials are now so exclusively adopted by many makers of steam-boilers and of rails. Such steel is steadily driving puddled iron from the market: it is called, sometimes 'Siemens,' and often 'Siemens-Martin' steel; the first attempts to manufacture steel by this method having been

successful in Great Britain through the efforts of Siemens, and in France by application of the Siemens furnace to this use by Martin. The Landore steel-works, started at Landore, Wales, in 1868, were the first to make steel by the Siemens methods on a considerable scale; and it was there that the great engineer conducted the more successful experiments of later years.

The tastes and the studies of the brothers led them, at an early date, to the examination of the lines of development of applied electricity. In 1848, or earlier, they became interested in telegraph-work, and both Charles and Werner began to apply their inventive talents to the production of telegraph instruments and apparatus of various kinds used in electrical measurements. Ten years later the firm of Siemens & Halske, of Berlin and of London, was formed; and they soon became the most extensive manufacturers of electrical apparatus in Europe. They began the construction of submarine telegraph-cables at an early date, and established, later, factories at Woolwich, England, and in Berlin and St. Petersburg. They finally built up their business to such an extent that it became necessary to have a large steamer constantly and exclusively employed in laying down their cables. The Faraday, named for their early friend, was constructed under the direction of Dr. Siemens, and has been since employed in the laying of the principal long cables under the Atlantic, in the Pacific, and under parts of the Indian Ocean. From this branch of electrical work to that of electric lighting was but a short step for these great men; and they have, during the past half-dozen years, been as well known for their success in the introduction of the Siemens system of lighting, and for inventions of apparatus and machinery in connection with it, as for their earlier inventions in other fields. All successful dynamo-electric machines have the Siemens armature; that method of winding, and its peculiar form, being especially fitted for introduction into the modern forms of dynamo. Their lamp has proved to be one of the best in use; and a multitude of details, worked out with characteristic ingenuity and care, has given their system, as a whole, a completeness, and a degree of perfection in operation, which have contributed in no small degree to the fame of Dr. Siemens. The wonderful combination of scientific knowledge with practical experience and information possessed by Siemens made him eminent in every department of application to which he chose to turn his attention. His success in raising capital for large operations was due to

his personal character, however, quite as much as to his reputation as a scientific man and a talented engineer. The firm of Siemens & Halske was thus able to secure concessions from the Austrian government for probably the most extensive system of elevated electric railways yet projected, and has begun its construction in the city and suburbs of Vienna. The success of such railways at the electrical exhibition was such as to give great confidence that such railway systems will supersede those now in operation by steam.

Physicists will honor Sir William Siemens as the inventor of the 'electric resistance pyrometer,' to which is so closely related Professor Langley's 'bolometer.' They will remember him as the discoverer of the influence of the electric light on vegetation, and as the inventor, also, of the 'bathometer' and the 'attraction meter.'

His papers are numerous, and many of them important: they usually relate to subjects closely connected with his work and his inventions and discoveries.

The greatest commercial and financial successes of Siemens and his partners have been in their telegraph-cable work, and, above all, in the introduction of the Siemens system of generating heat for metallurgical operations. This system is estimated to save, in the steel-works of the country, thirty to fifty per cent of the fuel used by earlier methods, to permit an increase of work done per furnace used in nearly equal proportion, to give a finer product in consequence of the purity of the flame, and many incidental advantages. It has saved to the people of the United States alone between twenty-five and thirty millions of dollars during the comparatively few years that these furnaces have been in general use.

The name of Charles William Siemens is honored in every civilized country; and every nation capable of appreciating the good work done by him has given expression to this appreciation. The British institution of engineers admitted him to membership many years ago, and made him a member of its council. He was awarded the Telford medal for his inventions, a distinction only accorded to the greatest of engineers for the greatest of inventions or constructions, and was given the Royal Albert and the Bessemer medals later. He was made a fellow of the Royal society of Great Britain, a member and a president of the British association for the advancement of science, and a member of the councils of both those societies. He was elected president of the British institution of mechanical engineers and of the Society of telegraph engineers, and was made a member of many foreign societies, both scientific and engineering. He was an honorary member of the American philosophical society and of the American society of mechanical engineers. He was given the degree of D.C.L. by Oxford, and of LL.D. by the universities of Dublin and Glasgow. He received many decorations, one of the latest of which was that just offered him by Austria at the Vienna electrical exhibition. He was knighted, a few months before his death, by Queen Victoria; and his sudden and premature death — for he was a man physically strong and sturdy, and evidently constructed for an octogenarian — did not occur so early as to deprive him of more numerous and greater honors of this formal sort than usually fall to the lot of even the greatest of men.

Sir William Siemens was a man of large, well-shaped frame, muscular rather than fat in his early years, but inclining to stoutness as he grew old. He had a noble, well-shaped head; large, strong, and characteristic features, which were mobile, kindly, and unusually expressive. His manners were those of a man who had grown to know his place in the world and to feel sure of a high place among men, quiet, composed, confident, without being in the slightest degree self-asserting, or at any time disagreeable to his associates, to friends, or to competitors in business. Equally at home in the courts of royalty, in the halls of science, and in the offices of business-men, he impressed every one whom he met with his strength, talents, knowledge, and *savoir faire*. He numbered among his friends the great in every department, — statesmen, men of science, engineers, inventors, and capitalists. He was equally honored and beloved by all, and loved equally well to entertain them all in his fine London mansion and in his beautiful country place, in both of which hospitable homes he met his guests with a plain, simple, and kindly greeting and conversation, which made them at once at home, and at ease with their entertainer. One of his most pleasing powers was that of adapting himself to the temperament and the methods of conversation of those whom he met, whatever their rank in life or their personal interests and lines of thought.

In his death is lost, to his intimates, one of the truest and best of friends; to his employees, a kind benefactor; to science, one of her most splendid workers; to the arts, one of the greatest among their promoters; to the world, one of the noblest among its few great benefactors.

ROBERT H. THURSTON.